

ALTERNATION OF THE PULSE: A COMMON CLINICAL CONDITION.

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THE purpose of the present communication is, in the first place, to express the frequency of pulsus alternans as a clinical condition, and, secondly, to report the analysis of histories, clinical findings, and cardiographic records of this series of cases. I have found alternation of the radial pulse in 71 patients in the wards and among the out-patients of the Massachusetts General Hospital during a period of eight months. Radial pulse tracings were taken from 300 cardiac and cardiorenal cases in all.

Pulsus alternans is that condition of the pulse in which strong and weak beats alternate, but in which the cardiac rhythm is normal. It includes constant alternation and alternation found in phases and after premature beats only. The pseudo-alternation due to the late appearance of premature beats and due to respiratory influences must be differentiated from the true alternation (Figs. 2, 3, 6, 7, 8, and 9).

The clinical literature on the subject includes reports of small numbers of cases, usually from one to four or five, with scarcely a hint that all around us alternation of the pulse lies undiscovered. Mackenzie¹ has seen the condition often during a considerable number of years, and now has records of "over 100 cases," collected during a decade or more. Windle,² in 1913, reported 45 cases collected during a period of over four years.

Gravier,³ in 1914, published a thesis in which, at considerable length, he discusses the theories of alternation and the experimental work on the subject, and details a study of 40 cases which he had collected with the help of Gallavardin during the course of two years. I would refer to his extensive bibliography for the literature on the subject.

Neither Mackenzie, Windle, nor Gravier⁴ express the frequency of alternation of the pulse. They indicate that it is not rare. It is the writer's aim to show that it is a common condition.

In the present communication the alternation found in the rapid pulses of auricular flutter (Figs. 1, 2, and 3) and paroxysmal

¹ *Diseases of the Heart*, 1913, p. 260.

² *Quart. Jour. Med.*, 1913, vi, 453.

³ *L'Alternance du Cœur, Étude Critique et Clinique*, Paris, 1914.

⁴ Gravier makes a prophecy on page 270 of his monograph "*L'Alternance du Cœur*" as follows: "Il ne fait donc pas de doute pour nous que le pouls alternant ne soit bientôt reconnu comme un *symptôme fréquent* de l'insuffisance cardiaque."

tachycardia (Fig. 4) is not included.⁵ Also, the pseudo-alternation due to respiratory blood-pressure changes (Figs. 5, 6, and 7) and to delayed appearance of premature beats (Fig. 8) is excluded. Doubtful cases of true alternans have been omitted. Of the 71

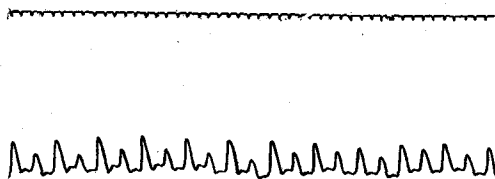


FIG. 1.—Pulsus alternans in a patient about two hours after the onset of an attack of auricular flutter. In tracings one hour and one and one-half hours after the onset of the flutter at the same rate as the present (144) no alternation occurred. Time interval = 0.2 second.

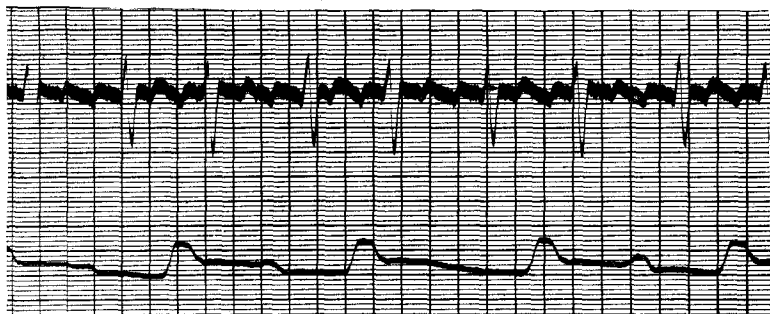


FIG. 2.—Pseudo-alternation from a case of auricular flutter. Simultaneous records of Lead II of the electrocardiogram above and radial pulse below. Abscissæ = 0.2 second. Ordinates = 10^{-4} volts.

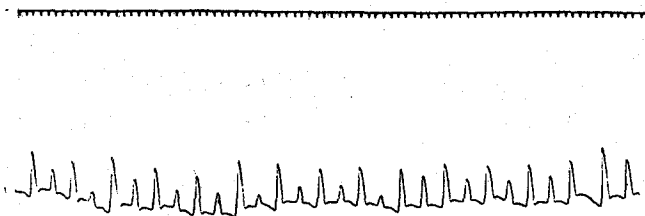


FIG. 3.—Radial tracing from patient whose record is shown in Fig. 2. Pseudo-alternation of auricular flutter. Time interval = 0.2 second.

cases found, 15 showed a constant alternation, 55 a post-premature beat alternation only, and 1 a phasic alternation.

⁵ During the eight months, three patients showing flutter and one showing paroxysmal tachycardia had alternation, the latter displaying the condition only at a rate of 185 and not at the lower paroxysmal rates of 150 and 100, or at the normal rate of 60, a fact which reveals the exhaustion rate of this heart.

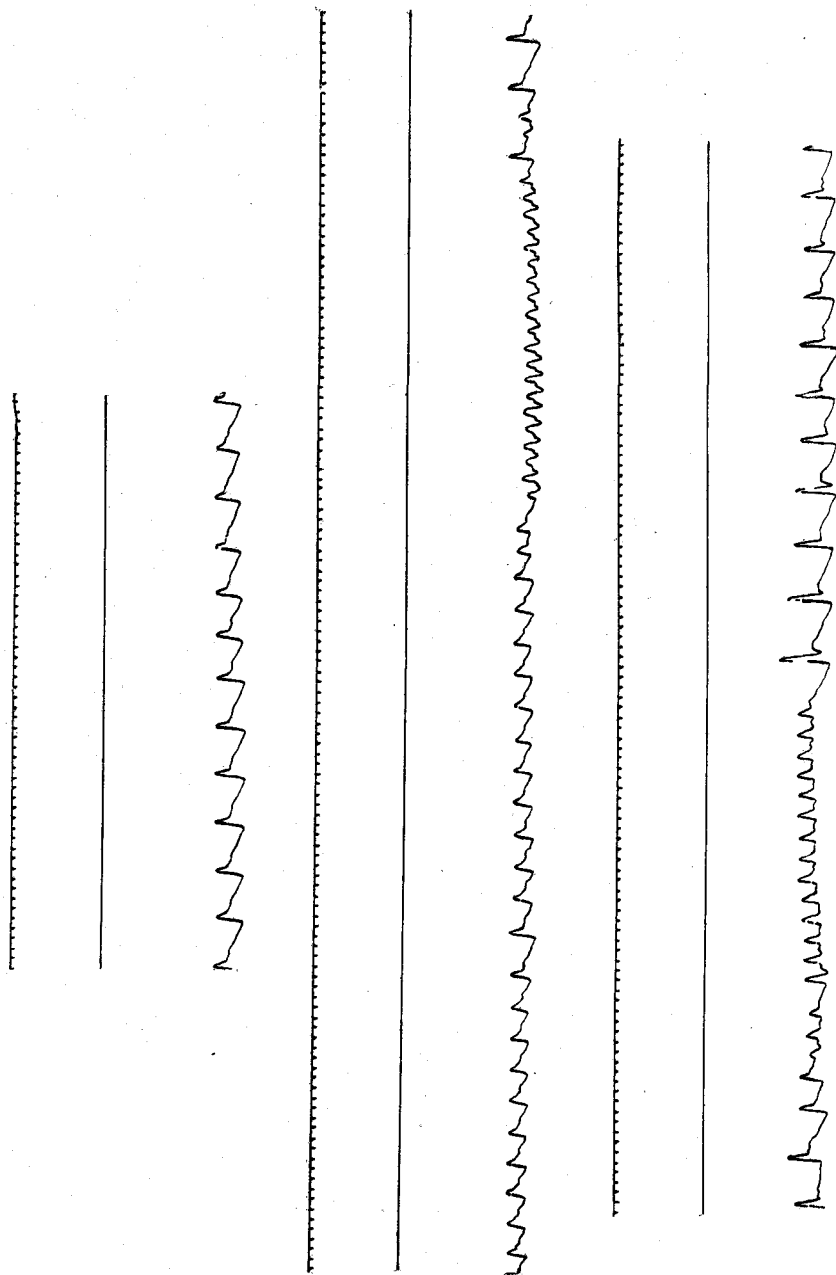


FIG. 4.—Radial tracing from a patient, showing three rates of paroxysmal tachycardia. Interval of a few seconds between strips of tracing. Upper tracing shows the normal rate (60); middle tracing shows two rates of tachycardia (first 100, second 185); lower tracing shows a short paroxysm at a rate of 150, with return to the normal rate of 60. Alternation is present in the pulse at the highest rate only. Time interval = 0.2 second.

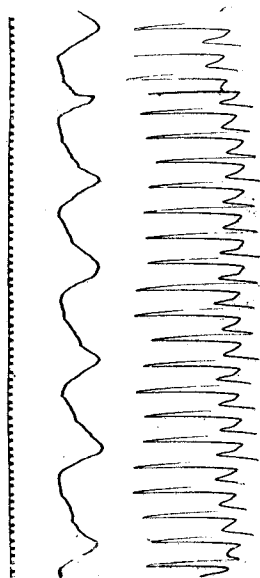


FIG. 5.—Simultaneous respiratory and radial tracings, showing well the respiratory change in the force of the pulse. In this instance pulsus paradoxus is present. In the respiratory record the rise of the curve represents expiration and the descent inspiration. Respiratory rate is 25, pulse rate 92 per minute. Time interval = 0.2 second.

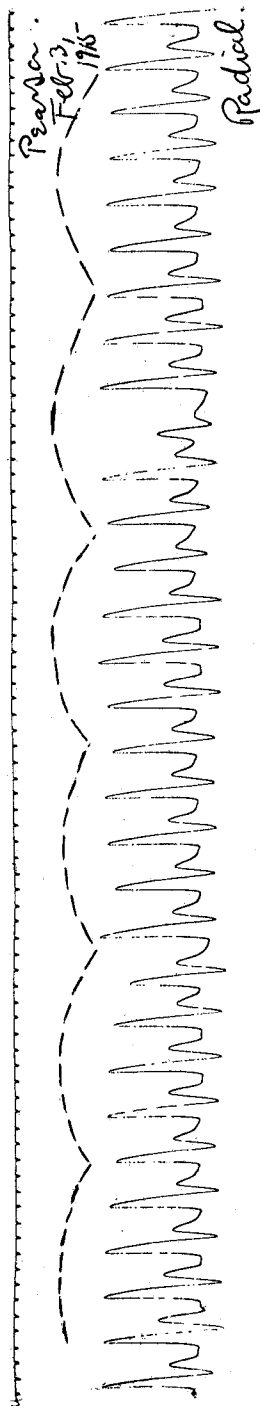


FIG. 6.—Pseudo-alternation following first premature beat. No alternation after second premature beat. Line of dashes represents the respiratory changes in the pulse volume. The first premature beat is followed by a natural rise in the volume while the second premature beat is followed by a drop. Hence the alternating beat after the first premature beat is due to respiratory and not myocardial conditions. Time interval = 0.2 second.

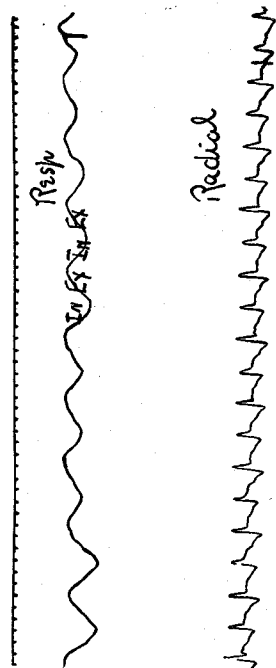


FIG. 7.—Simultaneous respiratory and radial tracings. Respiratory rate is 55 and pulse rate 110 to the minute. The alternation is due here to this exact relationship, and is not a true alternation. Downstroke in respiratory curve represents inspiration, upstroke expiration. Time interval = 0.2 second.

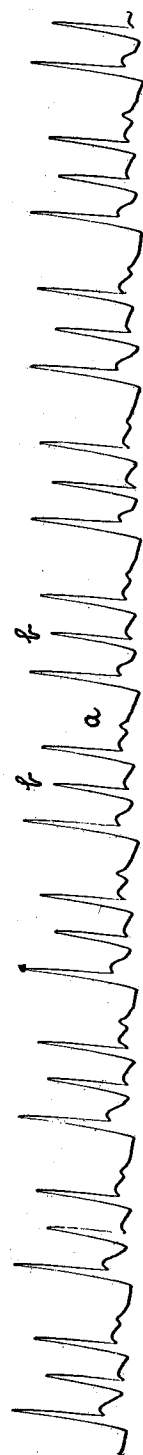


FIG. 8.—Radial tracings from same patient a few seconds apart, the upper one showing a pseudo-alternation due to bigeminy from ventricular premature beats, the lower record revealing a true alternation following a ventricular premature beat which falls every fourth beat. *a* = ventricular premature beat. *b* = weak alternating beat. Time interval = 0.2 second.

The findings by months has been quite uniform, 8 to 10 being the usual figure. From August 1, 1914, to November 30, 1914 inclusive 33 cases were found, and from December 1, 1914, to March 31, 1915 inclusive 38 more were discovered, making a total of 71 for the eight months. On the two medical services of 40 to 50 beds each, 51 patients were found to have pulsus alternans, 18 out-patients showed the condition, and 2 cases were found in the surgical wards. The medical services received the closest observation, although in these undoubtedly a few cases slipped by unrecognized and untraced. Among the out-patients and in the surgical wards relatively little time was spent. During two recent months in the out-patient department of the hospital, Dr. J. H. Pratt and four medical students limited their attention entirely to cardiac cases, and found among them 6 cases of alternation (8 per cent. of 74 from whom radial tracings were taken).⁶ This fact indicates that during eight months in which I studied the condition, probably less than half of the out-patient alternations were missed.

The frequency of alternation as compared with other abnormalities of the heart beat found by me at the Massachusetts General Hospital in eight months may best be shown in tabular form:

TABLE I.

| | |
|---|-----------|
| Ventricular premature beats | 119 cases |
| Pulsus alternans | 71 " |
| Auricular fibrillation | 71 " |
| Auricular premature beats | 22 " |
| Defective A-V conduction and block, including twelve bundle branch lesions (long As-Vs interval not preceded by digitalis administration) | 21 " |
| Paroxysmal tachycardia | 9 " |
| Auricular flutter | 6 " |

Alternation of the pulse was found in 33 per cent. of all cases showing any degree of cardiac decompensation from whom a radial pulse tracing was obtained. Table II shows the relative frequency of the various abnormalities of the heart beat in decompensation.

TABLE II.

| | |
|---|-------------------|
| Cases of cardiac decompensation traced in eight months | 201 |
| Pulsus alternans | 66 (33 per cent.) |
| Auricular fibrillation | 65 (32 per cent.) |
| Normal pulse | 24 (12 per cent.) |
| Ventricular premature beats without alternation | 20 (10 per cent.) |
| Defective conduction without alternation following digitalis | 12 |
| Defective condition with and without alternation following digitalis | 19 |
| Defective conduction without alternation not following digitalis | 8 |
| Defective conduction with and without alternation not following digitalis | 20 |
| Auricular premature beats without alternation | 4 |
| Auricular premature beats with and without alternation | 8 |
| Auricular flutter | 2 |

⁶ The writer is indebted to Dr. Pratt for these figures.

Seventy-two cases of non-fibrillating hearts showing hypertension (systolic blood-pressure constantly above 160 mm. of mercury) were examined, and of these 37, or *51 per cent.*, showed alternation. The association of alternation and hypertension has been pointed out by Windle,⁷ Gravier,⁸ Lewis,⁹ and others, and among the cases reported in the literature, hypertension occurred in a large percentage.

The relationship of age to pulsus alternans in the 71 cases is shown in Table III.

TABLE III.

| Years of age. | Number of cases of pulsus alternans. |
|---|--------------------------------------|
| 0 to 10 | 0 |
| 10 to 20 | 2 |
| 20 to 30 | 2 |
| 30 to 40 | 7 |
| 40 to 50 | 16 |
| 50 to 60 | 17 |
| 60 to 70 | 17 |
| Over 70. | 10 |
| 11 (15 per cent.) below the age of forty. | |
| 44 (62 per cent.) above the age of fifty. | |

The youngest patient was fifteen years of age¹⁰ and the oldest seventy-five years. The majority of Windle's patients were old arteriosclerotic people.

SEX. Of the writer's series 49 (69 per cent.) were male and 22 (31 per cent.) female.

In the attempt to determine the etiological factors of the cardiac condition the following data have been obtained:

TABLE IV.

| | |
|--|------------------------|
| Clear history of rheumatism, chorea, or tonsillitis | 9 cases (13 per cent.) |
| Clear history of syphilis | 4 " (6 per cent.) |
| Wassermann test positive (of 60 cases tested) | 9 " (15 per cent.) |
| Hypertension: systolic pressure constantly above 200 mm. mercury | 12 " (17 per cent.) |
| total constantly above 160 mm. mercury | 37 " (52 per cent.) |
| diastolic pressure (of 68 cases tested) above 100 mm. mercury | 32 " (47 per cent.) |
| Age, patients over fifty years ¹¹ | 44 " (62 per cent.) |
| Excessive alcohol | 13 " |
| Excessive tobacco | 12 " |
| Excessive tea or coffee | 11 " |

⁷ Loc. cit. ⁸ Loc. cit. ⁹ Clinical Disorders of the Heart Beat, 1914, p. 104.

¹⁰ A few days after the expiration of the eight months a girl, aged ten years, was discovered to have true alternation of the pulse.

¹¹ The relationship of the arteriosclerosis of old age and pulsus alternans has been studied by tracing the radial pulse of 69 patients at the Massachusetts State Hospital at Tewksbury and at the Long Island Hospital, City of Boston. Among these arteriosclerotic people, nearly all over sixty years of age, but few presented much evidence of cardiac decompensation, 5 showed alternation of the pulse, 4 in but slight degree after premature beats, 16 showed auricular fibrillation, 14 ventricular premature beats, 5 auricular premature beats, and 2 defective A-V conduction. The oldest patient, aged ninety-seven years, showed ventricular premature beats but no pulsus alternans; she looked as though she might readily live to be ten years older in spite of her marked peripheral arteriosclerosis. I am indebted to the resident physicians of the hospitals at Tewksbury and Long Island for the opportunity to examine their patients.

The severe acute infections are probably infrequently attended by alternation of the pulse. Of 10 severe cases of pneumonia and 4 of typhoid only 1 (typhoid fever with defective heart) showed alternation.

Digitalis played no part whatsoever in the etiology of alternation in more than half of the cases, for 40 patients had received none so far as I was able to determine prior to the pulse tracing. The failure to find alternation in the pulse of two typhoid patients who had a considerable degree of heart-block from digitalis or in that of two surgical cases in whom a postoperative digitalis blocking was produced (in one of these a prolonged *a-c* interval was found with a pulse rate of 105), suggest that digitalis may have played no role in the causation of the alternation in the other 31 cases of the series.

The relationship of clinical conditions such as angina pectoris to alternation has also been of interest. The present large series of cases affords useful data.

TABLE V.—CLINICAL CONDITIONS ASSOCIATED WITH THE ALTERNATION OF THE PULSE.

| | | |
|---|-------------------------|-----------------------------------|
| Dyspnea (constant or on slight to moderate exertion) | 66 cases (93 per cent.) | |
| Dyspnea without physical signs of decompensation | 28 " (39 per cent.) | |
| Dyspnea with very marked physical signs of decompensation | 9 " (13 per cent.) | |
| Angina pectoris | 6 " (8 per cent.) | |
| Cheyne-Stokes breathing | 6 " (8 per cent.) | |
| Albuminuric retinitis (18 fundi examined) | 8 " | |
| Albuminuria | 45 " | |
| Glycosuria | 3 " | |
| Valve lesions—Mitral stenosis alone | 3 " | } Total, 15 cases 21 per cent. |
| Aortic valve lesion alone | 4 " | |
| Aortic and mitral | 5 " | |
| Mitral regurgitation alone | 3 " | |

Hypertrophy of the heart was usually found on physical examination and 24 cases which were examined with the Roentgen-ray (the patient's chest seven feet from the tube) showed definite cardiac enlargement in every instance. The great vessels were abnormally wide in 5 of the 24 cases.

FINDINGS BY GRAPHIC METHODS.—The pulse of each case was examined with the Mackenzie ink polygraph and 44 of the 71 cases were also electrocardiographed. The following two tables show the analyses of the records made.

TABLE VI.—POLYGRAPHIC RECORDS.

| | |
|---|-------------------------|
| Constant alteration (Fig. 9) | 15 cases (21 per cent.) |
| Alternation after premature beats only | 55 " (77.5 per cent.) |
| Alternation after premature beats only (marked) (Fig. 10) | 15 " (21 per cent.) |
| Alternation after premature beats only (slight) (Fig. 11) | 40 " (56.5 per cent.) |
| Phasic alternation | 1 case |
| Ventricular premature beats | 67 cases (94 per cent.) |
| Auricular premature beats (3 with v.p.bs.) | 4 " (6 per cent.) |
| No premature beats | 3 " (4 per cent.) |
| Defective A-V conduction (two after digitalis) | 3 " |
| Paroxysmal tachycardia at other times | 2 " |
| Pulse rate at time of alternation: | |
| Under 100 per minute | 53 " (75 per cent.) |
| Lowest rate, 57; highest rate, 125. | |

TABLE VII.—ELECTROCARDIOGRAPHIC RECORDS (44 OF THE 71 CASES WERE ELECTROCARDIOGRAPHED).

| | |
|---|------------------------|
| Evidence of lesion of right branch of A-V bundle | 7 cases (16 per cent.) |
| Evidence of lesion of left branch of A-V bundle | 0 " |
| Evidence of defective A-V conduction (long P-R interval) not after administration of digitalis | 5 " (11 per cent.) |
| Other cases with long P-R interval after administration of digitalis | 7 " |
| Aberrant ventricular complexes (other than bundle branch lesion) | 3 " |
| Total of cases evidencing damage to conducting system (including one discovered with the polygraph) | 15 " (34 per cent.) |
| Left ventricular preponderance | 22 " |
| Right ventricular preponderance | 3 " |

The *T* deflection was flat or inverted in 13 and low in 2 of 24 cases who had not been taking digitalis.

Eighteen of the 44 electrocardiograms showed premature beats, and in 7 of these cases there was slight alternation of the *T* deflections afterward (Figs. 12 and 13), in 6 in accord with the radial alternation and in one in reverse order. In 3 cases there was slight alternation of the *R-S* deflections after premature beats. No constant alternation of the *R-S* or *T* deflections occurred. There was no alternation of the *P* complexes found.

Sinus arrhythmia was a frequent finding.

TABLE VIII.—SINUS ARRHYTHMIA ASSOCIATED WITH ALTERNATION OF THE PULSE.

| | |
|------------------------|-----------------------|
| Marked | 6 cases (8 per cent.) |
| Moderate | 20 " (28 per cent.) |
| Slight | 16 " (23 per cent.) |
| None | 20 " (28 per cent.) |
| Questionable | 9 " (13 per cent.) |

The small percentage of marked sinus arrhythmia occurring with the alternation is probably accounted for by the relatively old age of the majority of the patients, but the frequency with which some degree of sinus arrhythmia occurred with pulsus alternans in the



Fig. 9.—Constant pulsus alternans. Rate 102 per minute. Time interval = 0.2 second.

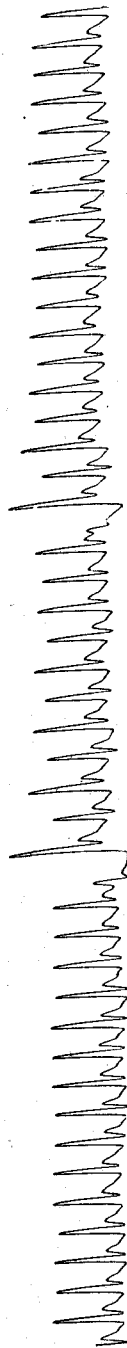


Fig. 10.—Marked postpremature beat alternation. Rate 84 per minute. Time interval = 0.2 second.

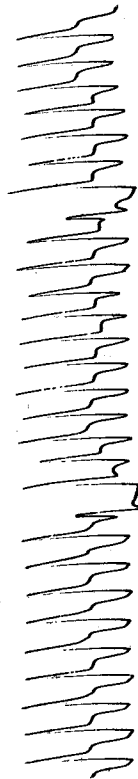


Fig. 11.—Slight postpremature beat alternation. Rate 87 per minute. Time interval = 0.2 second.

present series is a noteworthy fact. The response of the heart to nervous impulses may be active, although the cardiac contracting power is much diminished.

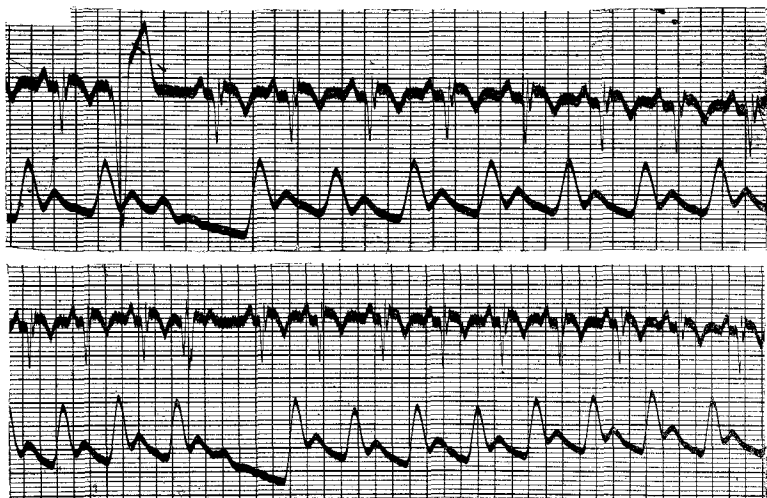


FIG. 12.—Simultaneous records of electrocardiographic Lead II and radial pulse of patient, showing slight post-premature beat alternation. Note slight alternation of the *T* deflections after the premature beats. Time interval = 0.2 second.

THERAPY. Digitalis was given to 53 of the 71 cases and clinical improvement followed in 32 cases (60 per cent.), illustrating well



FIG. 13.—Leads I, II, and III of patient who showed slight alternation of the radial pulse after ventricular premature beats. Note post-premature beat alternation of the *T* deflections. Left ventricular preponderance is shown by Leads I and III. Abscissæ represent fifths of a second, ordinates represent 10^{-4} volts.

the fallacy of the old-time belief that it is unwise to give digitalis to an alternating heart. In 4 cases the degree of alternation was

lessened after digitalis, in others judgment could not be passed because premature beats which had appeared and had been followed by alternation no longer occurred after the administration of digitalis.

PROGNOSIS. One of the most important relationships of alternation is that to prognosis. Since but a very short interval has elapsed since the eight months during which the cases here recorded were collected, it is impossible to give more than a suggestion as to the prognostic significance of the pulsus alternans. Twenty-two of the cases (31 per cent.) are known to have died during the eight months, most of them a few months after the condition was discovered. During the ninth and tenth months three more are known to have died, making a total to date (June 1, 1915) of 25 deaths (35 per cent.). Of the 25, one patient is known to have had pneumonia at the time of death, another streptococcus septicemia, a third malignant disease of the liver, and a fourth was comatose following a cerebral hemorrhage. Two of the 25 were below the age of forty years (the younger being fifteen years old) and 13 were over fifty years old; 10 had visited the out-patient department of the hospital within a few months or a few weeks before death; that is, they were ambulatory patients at the time their alternation was in progress.

The relationship of the degree of alternation to prognosis is shown in the following table:

TABLE IX.

| | Number. | Dead. | Percentage. |
|---|---------|-------|-------------|
| Cases showing constant alternation | 15 | 8 | 53 |
| Cases showing marked post p. b. alternation | 15 | 7 | 47 |
| Cases showing slight post p. b. alternation | 40 | 10 | 25 |

Tabora¹² has spoken of a case of pulsus alternans alive six years after the condition was found; this is the longest survival on record.

Pathological Findings. Of 6 cases dying at the Massachusetts General Hospital, 3 came to autopsy. All 3 showed coronary sclerosis in some degree, and 2 also showed on gross examination of the endocardium areas of fibrosis; 1 case showed marked sclerosis of the aorta.

The weights of the three hearts were high—384 grams, 403 grams, and 475 grams respectively.

Microscopic examination of the kidneys showed in all an arteriosclerotic nephritis.

VALUE OF METHODS OF DETERMINING ALTERNATION. A graphic record of the pulse is the only satisfactory method in searching for alternation, and even then one must be prepared to take a record of considerable length. This can be done well with an ink sphygmograph, long rolls of paper being available at very little expense and effort.

¹² Conversation with Gravier, "L'Alternance du Cœur," p. 282.

Palpation of the radial pulse revealed the alternation in 13 of the 15 cases showing the condition constantly. It was also felt in several of the cases of post-premature beat alternation, but this finding is very unreliable, because of the impossibility to detect the difference by the finger between very late premature beats (as in a bigeminal pulse) and weak alternating beats. This criticism applies also to Gravier's delicate bimanual method. Rarely this difficulty may also be experienced in the radial tracing itself on measurement. In such instances a simultaneous jugular tracing or, better still, an electrocardiogram will settle the matter.

Auscultation of the heart is notoriously unreliable. Kahn¹³ has published experimental phonocardiograms showing the alternation in intensity of the heart sounds in dogs whose hearts were alternating; but when one listens to the hearts of patients whose radial pulse alternates, the difference in intensity of the sounds is slight at the most. In one case of the 71 recorded here who showed very marked constant pulsus alternans, the heart sounds varied not at all in intensity.

Rehberg's test,¹⁴ which consists of the finding of a difference in the blood-pressure of alternating beats is cumbersome but reliable if a graphic record is taken; the auscultatory method in the use of the blood-pressure cuff is unsafe on account of the inaccuracy of auditory measurement in distinguishing between late premature beats and alternation.

DELAY IN THE APPEARANCE OF THE SMALL ALTERNATING BEAT AT THE WRIST. This delay was pointed out in the first description of pulsus alternans by Traube¹⁵ himself in 1872, and has been frequently found since. Of the 15 constant alternations in the present series, 6 showed well this delay, 5 showed it slightly, and 4 failed to show any measurable delay. An analysis of 25 post-premature beat alternations shows a simple delay of the small beat or beats in 12 without apparent shortening of the *As-Vs* interval after the premature beat. In 5 cases the *As-Vs* interval after the premature beat was shortened, and in 7 cases there was a combination of this shortening with the usual alternation delay, thus magnifying the delay of the first weak alternating beat (Fig. 14). Sinus arrhythmia sometimes confused the picture slightly, but the curves were studied which showed none or very little.

OTHER OBSERVATIONS. The relationship of the prematurity of the forced beats to the degree of alternation is seen, as a rule, only in comparison of early beats with those coming so late that they occur almost at the normal point after the preceding beat (Fig. 15). In such cases the alternation is greater after the more premature beat, a condition that would be expected on account of the

¹³ Arch. f. d. ges. Physiol., 1911, cxl, 471.

¹⁴ Ztschr. f. klin. Med., Berlin, 1909, lxxviii, 247.

¹⁵ Berl. klin. Wchnschr., 1872, ix.

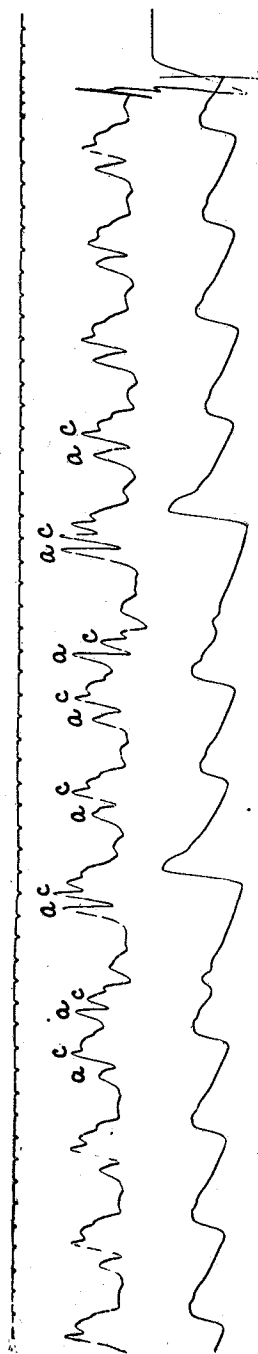


FIG. 14.—Polygram from patient exhibiting slight post-premature beat alternation. The upper record is of the jugular pulse, the lower of the radial pulse. Two auricular premature beats are shown. The *a-c* interval following each premature beat is shortened. Time interval = 0.2 second.

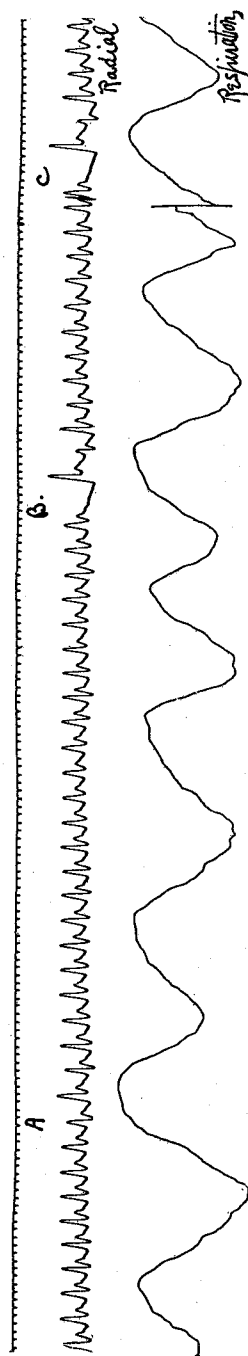


FIG. 15.—Simultaneous respiratory and radial tracings from a patient exhibiting post-premature beat alternation. In the respiratory curve the rise represents expiration and the descent inspiration. The late premature beat at *A* is followed by much less alternation than the early premature beats at *B* and *C*. Time interval = 0.2 second.

greater burden on the heart with the early beat. The alternation preceding premature beats as described by Windle¹⁶ has been seen by the writer only in a patient who, while showing waves of increase and decrease of a constant alternation, happened to have a premature beat soon after the increase had begun. The sixth radial upstroke in Fig. 7 of Windle's paper may represent a late premature beat, thus explaining the alternation following.¹⁷

The relation of respiration and degree of post-premature beat alternation has been found to consist of a slight increase during inspiration and a slight decrease during expiration with ordinary breathing; with the *pulsus paradoxus* of thoracic respiration the reverse might be expected.

SUMMARY. True alternation of the radial pulse has been found in 71 of 300 cardiac and cardiorenal patients examined with the sphygmograph by the writer at the Massachusetts General Hospital in the course of eight months (August 1, 1914, to April 1, 1915).

It has occurred as commonly as auricular fibrillation;¹⁸ 66 of 201 cases examined who were suffering from cardiac decompensation in some degree showed *pulsus alternans*; 65 others of the 201 showed auricular fibrillation; 15 of the patients having alternation showed it constantly, 55 after premature beats only and 1 showed a phasic type. The finding of ventricular premature beats has been of considerable value in the present series, 77 per cent. of the cases requiring the premature beats before the alternation of the pulse was exposed.

The condition was found most often in people in late middle life or in old age. Hypertension was associated with the alternation in 52 per cent. of the cases. Cardiac enlargement was practically a constant finding. Syphilis and rheumatism apparently played a less important part in the production of the myocardial weakness than did arteriosclerosis.

Electrocardiographic examination of 44 of the cases gave evidence of damage to the *A-V* conducting system in 15 cases, or 34 per cent. Electrocardiographic alternation was found in the *T* deflections after premature beats in 7 of 18 cases which showed premature beats on the records obtained. Only in 3 cases was there any alternation of the *R-S* deflection after premature beats.

Sinus arrhythmia occurred frequently in the series.

Digitalis and rest in bed produced clinical improvement in 32 of 53 cases in which digitalis was administered even though the *pulsus alternans* may have persisted. In 4 cases the alternation was diminished or banished after this therapy.

¹⁶ Heart, 1910, ii, 95.

¹⁷ Gravier has made this same observation concerning Windle's tracing, "*L'Alternance du Cœur*," p. 151.

¹⁸ In 1906 A. Hoffman (Münch. med. Wehnschr., 1906, liii), wrote of finding 10 cases of complete arrhythmia and 10 cases of alternation of the pulse out of 183 cases traced.

Twenty-five of the 71 cases died within ten months from the beginning of this study, the majority of the deaths so far as could be determined attributable to the cardiac condition directly. The relationship of the degree of alternation to prognosis was as one would anticipate, the greater the degree the shorter the life after the pulse discovery.

Arteriosclerosis of heart and kidneys was found in the only three cases examined postmortem.

It gives the writer pleasure to acknowledge his indebtedness to members of the hospital staff for their coöperation.

MODE OF ACTION AND USE OF EMETIN IN ENTAMEBIASIS.

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THE value of emetin in amebic dysentery is so well established that the further report of cases successfully treated would scarcely be of general interest at the present time. The literature on the subject is rapidly becoming voluminous, but the present status of the drug in the treatment of amebiasis has been excellently summed up in a rather recent paper by Vedder.¹ During the past eight months still further facts have come to light, so that the present communication will be limited to a practical discussion of the advances made in our knowledge concerning the mode of action of the drug, best methods of administration, dosage, ill effects, relapses, and other points of interest. In considering the mode of action of emetin in entamebiasis it will be necessary to inquire somewhat briefly into the habits and habitat of amebas in the body, and while some of the views expressed may be later proved incorrect, they at least permit of a rational basis for therapy.

MODE OF ACTION OF EMETIN AND IPECAC IN ENTAMEBIASIS. The exact manner of action of ipecac and emetin in amebic disease was until a few years ago very indefinite. In the old days of ipecac therapy there were many theories but few facts. It can be stated now from experimental and clinical evidence that emetin is the active principle of ipecac from the amebicidal point of view. In 1912 Rogers² by the subcutaneous and intravenous use of emetin demonstrated that it owes its action chiefly at least to absorption

¹ Origin and Present Status of the Emetin Treatment of Amebic Dysentery, Jour. Amer. Med. Assoc., 1914, lxii, 501.

² Rapid Cure of Amebic Dysentery and Hepatitis by Hypodermic Injections of Soluble Salts of Emetin, British Med. Jour., June 22, 1912, p. 1424.